Assignment 1: Review of SR
Due: January 16, 2008

PHYX442-0 Winter 2008 : Collider Physics

Homework Assignment 1 : Review of Special Relativity

1. Decay of a Classical Massive Vector Particle

Consider a massive (mass M) classical *vector* particle, whose internal angular momentum is described by a polarization vector ϵ_μ. It decays into two massless particles, each carrying some unspecified (unmeasured) internal angular momentum. Write down the complete set of Lorentz invariants characterizing the decay, and use energy and momentum conservation to reduce them to the independent set. Explain what each invariant means to an observer sitting the particle's rest frame. (This is a classical treatment of a vector particle, because we have not (yet!) quantized its spin).

2. Boosts and Angles

Consider a particle of mass M that decays into two massless particles isotropically in its rest frame. (That is, its decay products are distributed equally in all directions in the rest frame).

A. Now consider an observer O' who sees the particle moving with energy E along the direction of the (positive) z-axis. Consider one particular decay in which one of the decay products make an angle θ with respect to the z-axis in the particle's rest frame. Derive the formula for the angle θ' that the observer O' observes for that decay product.

B. For $M = 100$ MeV and $E = 1$ GeV and $E = 100$ GeV, evaluate the angle θ' observed by O' for a decay in which the decay product makes an angle of $\theta = 90$ degrees with respect to the z-axis in the particle rest frame.

C. Repeat part **B** for an angle of $\theta = 180$ degrees (i.e. when the decay product is traveling along the negative z-axis in the particle rest frame).